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Procedures For the Identification, Evaluation, and Reporting of Potential Waterpower and Reservoir Resources.

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National Applied Resource Sciences Center
Waterpower and Reservoir Resources
November 1999

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Procedures For the Identification, Evaluation, and Reporting of Potential Waterpower and Reservoir Resources.

The responsibility of the program is the identification, evaluation, and reporting of potential waterpower and reservoir resources. The function of evaluating Waterpower and Reservoir Resource (WRR) sites has been occurring since 1888. Tremendous historical efforts by highly professional personnel are reflected in waterpower program files, although much of the detail from those efforts has departed with those professionals. The movement of the program through the Minerals Management Service to the Bureau of Land Management has detrimentally effected the program . Now that the program has lost the prestige and confidence which was established by them, the evaluation of sites must be carefully and completely done. They must also be defendable to all who would question the evaluations or the program itself. It is regrettable that more accurate documentation of previous evaluations was not kept as it would have saved considerable time. It is resolved that further efforts will not be wasted, that efforts available from past experiences will be utilized for economic and professional credibility, and that current efforts will be properly documented for the future.

BUILDING THE SITE INVENTORY SYSTEM

An engineer is only as good as his library,
and his effectiveness is controlled by
the organization of that library.
TJK

A Functional Filing System

The Site Inventory System adopted by the Waterpower Program in 1978 is the framework for organization and storage of site evaluation documentation. This system is designed to provide "keys" to assist in the rapid location of all information. The system must be maintained and, as new information is generated or new reports are obtained, this information and the keys to it must be developed. The original report describing the Site Inventory System is in the Appendix (Historical Information). The following statements are a reflection of our experiences in developing the filing system:

3 Scan Existing Textural Files.

4 Search the Technical Working Files (BWC).

Search the Technical Working Files (BWC 639.3) for information regarding potential sites. Scan all "Classification Files" which may contain information regarding the subject area or specific sites in the area.

Formal Orders of Withdrawal or Revocation (BWC)

In the past these have included Executive Orders, Secretarial Orders, and District Geological Survey orders; however, such formal orders are now issued only as Public Land Orders by the Secretary of the Interior under Bureau of Land Management regulations. Formal orders through July 1952 are bound in volumes by States, and orders therein are segregated by types of actions. These files contain the transmittals proposing preparation of a Public Land Order (PLO), and a copy of the PLO as published in the Federal Register (Branch of Waterpower Classification Manual (BWC), Part 639.3.2). Any site specific information should be collected from these orders, reflected in the "keys" of the Site inventory System, and filed accordingly.

Minutes Files (BWC)

Minutes are detailed accounts of the basis for specific classification actions. Such records contain summaries of investigations, and all correspondence and documents relating to that particular action (BWC, Part 639.3.3). Any site specific information should be collected from these files, reflected in the "keys" of the Site inventory System, and filed accordingly.

Graphic Township Cards (BWC).

Graphic Township Cards show current status of reservoir and power withdrawals and classifications by public land subdivisions. The 5 x 8-inch cards show a township diagram about 4.35 inches square (approximate scale 1:87,400) and provide room below for indicating color coding, type of action and number, remarks, and dates. Sets of township cards are filed by Meridians and Base Lines, and are segregated by States. Larger scale (1:62,500) township cards prepared from standard United States Geological Survey's (USGS) 15 ' topographic maps have also been used, when appropriate, for plotting withdrawals and classifications (BWC, Part 639.3.6). Occasionally site information has been drawn on these cards, and any site specific information should be collected from these cards, reflected in the "keys" of the Site inventory System, and filed accordingly.

5 Search the River Basin Files (BWC).

Search the Stream Files as defined in the Site Inventory System for information regarding potential sites. When the Site Inventory System was adopted by the Waterpower Program in 1978 is the framework for organization and storage of site evaluation documentation. This system is designed to provide "keys" to assist in the rapid location of all information. Scan all Stream Files which may contain information regarding the subject area or specific sites in the area. Any site specific information should be collected from these files, reflected in the "keys" of the Site inventory System, and filed accordingly.

6 Search the Federal Power Project Files.

Search the Federal Power Project (FPP) Files for information regarding potential sites. Scan all FPP Files which may contain information regarding the subject area or specific sites in the area. These are records of all FPP Withdrawals of Federal lands made pursuant to the filing of projects under the Federal Power Act (BWC, Part 639.3.7). This material is furnished by the Federal Power Commission (now the Federal Energy Regulatory Commission (FERC)). Any site specific information should be collected from these orders, reflected in the "keys" of the Site inventory System, and filed accordingly.

7 Scan Existing Illustration Files.

There is a large collection of mapping products that has been generated over many years. The support for the Site Inventory System has left valuable information shown on these maps. United States Geological Survey (USGS) quadrangle maps are generally the greater portion of the map files, and consist mainly of 7½ - and 15 - minute series (BWC, Part 639.4.6C(1)).

Inventory Illustration File.

All sites are plotted on quadrangle maps showing the locations of dams, powerhouses, conduits and pipelines (BWC, Part 639.4.6D(2).

River Survey Files.

There is a file for all river survey maps which contains dam and reservoir site surveys (BWC, Part 639.4.6C(3)).

The map coverage of an area should be searched and any site specific information should be collected from these orders, reflected in the "keys" of the Site inventory System, and filed accordingly.

A Focused Literature System

9 Scan The Available Literature.

If new reports are received or if the original records are to be reviewed, the reviewer's first step is to conduct a literature search in order to document site references. This is achieved by scanning the literature, listing the references found, the sites in each reference, and the reference to each site. The procedures for making a literature search of published reports is in the Appendix (Procedures). The procedure is similar for reviewing all information. Scan the overall document, scan areas of importance to the program, decide if the entire document or portions of it are to be retained, and make reference keys and other references relating to the document and where it will be filed. All documents found in the following searches should be reviewed and keyed into the system.

Our experience has shown that the person who reviews the information obtains the institutional memory of the program. The person would preferably be the water and reservoir resources specialist. Second choice would be an engineering technician from a resource area related to the information. Because of the broader scope of many of the sites and publications, District personnel are suitable as reviewers. An engineering technician was used in the past because, although other disciplines can read and document what has been written, they are not familiar with technical numbers and do not comprehend the magnitude of the findings. Other discipline could also have difficulty documenting or converting the numbers into standard units.

10 List the Sites and the Reports.

The keys to the filing system consist of references, sites in each reference, and references listed by site. The information that is found as well as its location needs to be documented. It is recommended that these keys be tracked by developing and utilizing the pertinent information in a data base.

11 List the References Found.

Search all available literature As the documents are reviewed, the reviewer is to construct a table by listing the sites referenced in files or literature. This is done in order to document and rapidly find site information by entering specific information found onto a provided form and listing every page or memo that contains site information. Attached to the procedure for making the literature search is an example of how to complete an Inventory Site Card as defined in the Site Inventory System under Inventory Card File. Also included is CSO standard form 7250-1, "Book Review Sheet," which is actually a table for entering information found in a reference.

12 List the References on Each Site Card.

The Book Review Sheet is then used to list all references to a site on the Site Card. This documents the references to the site by listing all of the references in chronological order under the "Remarks" section. This office developed a personal computer data base application called "CARDS," which included type of site, a code for stream location, site number, legal location, file information, and references, in order to expedite the finding and conveying of information.

13 List the References.

List the sites in each reference and the reference to each site. After the decision is made where the document will be filed, the reviewer compiles a list of all references and their locations. This is done to quickly locate references by entering the title, agency, author, date, "stream code," name of file, number of sites, reviewer, and the date reviewed into a library reference. In the Site Inventory System, this reference is referred to as an "Index - Inventory Filing System." The card reference index to publications for this office was so outdated that it was discarded. A personal computer data base application called "TITLES" was developed in its place.

Vital Original Information

15 Site Evaluation File

The evaluation of a site as described in this handbook requires the generation of a Site Evaluation File. This Site Evaluation File is then filed in Stream Files under the subheading of "Site Evaluations." A complete existing file which was previously generated during an evaluation has been copied and included in this hand book under the title "Evaluation File (Site Specific)." Note that in accordance with filing procedures, the file is built from the rear forward. The notebook tabs guide reviewers to the appropriate sections.

16 Site Report

The evaluation of a site, as described in this handbook, requires the generation of a Site Report. This report is filed in Stream Files under the subheading of "Reports." A complete existing report has been copied and included in this hand book under the title "Report (Final)."

17 Mapping Products

The Inventory Map and the Inventory Illustration File, as defined in the Site Inventory System, are used to determine which sites have information and may be of interest. The following procedures are a guide to the identification of a site regardless of whether the site has or has not been evaluated in the past. The only assumption is that there is interest in a potential site in a specific area.

BUILDING LAND VALUE FILES

The land which may be inundated by a potential reservoir have unique value which, by statute, are to be withdrawn. Tremendous accomplishments have already occurred. Any new site investigation should not be considered without considering past accomplishments and prior investigations. These past efforts have remnant information in the files. This information needs to be standardized for efficient and comprehensive understanding. A visual representation is the easiest to understand. At this time it is important to develop a map showing existing withdrawals on a standard topographic map.

Withdrawals and Status

All bureaus in the Department of the Interior are responsible for maintaining accurate and current records of all lands withdrawn for their programs (DOI Manual 603.1.2C). The waterpower withdrawals were made by the U.S. Geological Survey who kept meticulous records. The charge to withdraw all vacant federal land valuable for waterpower and reservoir resources requires status checks, the listing of already withdrawn land, and preparation to withdraw vacant land. The following steps are to determine the value or lack of value of all withdrawn land in order to insure complete review of each withdrawal.

20 Reconcile USGS and BLM Records.

The Federal Land Planning and Management Act (FLPMA), requires that the former withdrawal records of the Geological Survey and those of the Bureau of Land Management be reconciled with each other. Not all of these records have been reconciled. The first step is to determine outstanding waterpower withdrawals by ensuring there is an audit for each withdrawal and summarizing all withdrawals for each basin in order to review the outstanding withdrawals in a "review unit."

The following procedures were followed by the USGS staff to insure accuracy and quality control. They are described in BWC 639.3.5 (Area Ledgers).

21 Make an "audit" for Each Waterpower Withdrawal.

Make an "audit" for each waterpower withdrawal in order to ensure that the official land records reflect the actual case. Memoranda giving specific procedures are included in APPENDIX (Procedures), Audit Procedures. The directives for filing these audits are unclear. Informally they are most often found in the "minutes files."

22 Make a Township Summary From Each Audit.

Make a township summary from each audit by using established procedures in order to reflect amounts in larger quantities.

23 Make a File Summary From Each Township Summary.

Make a file summary from each township summary in order to reflect the land in withdrawal in each withdrawal action.

The listed steps are accomplished manually but efficiency dictates automation be used. If the land descriptions, withdrawal number, the land value, land administration agency, and acreage were entered into a computer using a relational data base software package, this process would be very straightforward and efficient.

24 Assign a BLM Case File number.

Assign a BLM Case File number. The Realty Specialists will ensure that the file information is reflected on the Master Title (MT) plats and Historical Indexes.

Withdrawn Valuable Land

The first step is to determine what lands values have been identified previously. This can be quickly communicated visually by showing already identified potential sites with the existing withdrawals. The following listed steps are accomplished manually but efficiency dictates automation be used. If the reservoir sites are digitized and the Geographic Coordinate Data Base and Legal Land Description files are available, this process can be completed on a terminal screen.

26 Draw the legal subdivision lines.

Draw the legal subdivision lines onto the Inventory Illustration File's quadrangle maps. Not all of the lines are necessary. Draw the lines in the sections around the perimeter of the high water line of the reservoir using established procedures.

27 Determine the lands Effected by Resources.

Determine the smallest legal subdivisions effected by a reservoir by listing the subdivisions within or effected by the dam or high water line in order to assign a value to the land subdivisions.

28 Determine the Land Acreage for Each Resource.

Determine the total land acreage in each classified reservoir by adding the acreage for each subdivision listed.

29 Draw the waterpower withdrawals.

Draw the outlines of the lands with outstanding waterpower withdrawals on the Inventory illustration File's quadrangle maps showing location, size and shape of the boundary of the withdrawals to determine the topographic conditions of withdrawn land.

30 Review the Plotting of Withdrawals and Resources

Review the plotting of withdrawn lands and reservoirs on topographic maps by using "Review of Withdrawals" and "Site Evaluation" folders to confirm the plotting is what was described in order to assign values to legal subdivisions of withdrawn lands.

31 Determine the Subdivisions of Each Withdrawal Effected

Determine the smallest legal subdivision of each withdrawal effected by a site by noting subdivisions within, or effected by, the dam or high water line to assign a value to the subdivisions.

32 Assign a Resource Value to Effected Withdrawals

Assign a reservoir value to the effected withdrawn lands by placing the reservoir site name in the value column of each subdivision effected to document known values.

Non-Valuable Land

34 Determine Withdrawal Without Resource Values

Determine the smallest legal subdivision of each withdrawal not effected by any reservoir site by noting subdivisions outside or not effected by any reservoir site in order to remove any assigned value from the subdivisions.

35 Assign a Lack of Value to Appropriate Withdrawals

Assign a value or the lack of a value to the withdrawn lands not effected by a reservoir. List other values, or the reason for a lack of value, by listing the value or reason for lack of value in the "value" column of each subdivision. This documents the findings.

Land Administration and Constraints

37 Determine the Land Status of Effected Lands.

Determine land status of effected lands by obtaining Master Title (MT) plats and Historical Indexes and checking the land lists with the status records in order to adjust classifications effecting vacant public lands.

38 List All Effected Federally Owned Lands.

List all Federally owned lands which are protected for their water resource value by withdrawal. List all vacant public lands not protected by any withdrawal. These steps communicate results to other personnel for checking or for their use.

39 List the Land Administration Agency.

List the land administration agency of each subdivision from statewide status maps on the "summary sheets" in order to determine reactive workloads for those agencies . The sites and the acreage in each agency should be tabulated and the information shared with the management agency.

40 Check for Legal Constraints.

When the Bureau of Land Management decided to remove all withdrawals that were in areas where reservoirs were prohibited, a screening process was accomplished. One step was to note the areas of legal constraints by listing areas of National Parks, Wild and Scenic Rivers, etc., from statewide status maps, Wild and Scenic River maps, etc., in order to screen sites which do not need to be evaluated due to legal constraints.

Verification of Withdrawal Decision Point.

On March 13, 1986, the existing waterpower experts discussed the initial draft of the WRR Task Statements. From my notes of that date, there were requests to make clear points of decision whether to evaluate the site further, or if they could make the decision with the information already available. Decision Points were subsequently added and were originally called toggle switches (TS). The idea reflected the concept that it was a yes or no decision, that a toggle switch was either off or on. A consciences decision is to be made after clarifying that the site does affect a withdrawal, or potential withdrawal, and that there are no legal impediments to the development of the site. A qualified Reality Specialist could state that the land status of the Resource site does not preclude further effort.

SITE IDENTIFICATION

Good management dictates that tasks will not be repeated if they are accomplished competently

and thoroughly the first time. The exceptions are: 1) If the first efforts are not repeatable; 2) if it can be accomplished more rapidly than the effort to find the original; and 3) if the scenario or facts are different and require a different evaluation. An efficient filing system is in place to find the original efforts; now the information must be evaluated for accuracy and the original scenario under which it was accomplished. Efficiency dictates communication of the findings to other personnel to avoid further assessments and/or the unnecessary duplication of effort.

Mapping Support

Lack of quality mapping is detrimental to proper evaluation of a site. At this point, all available maps should be documented. The failure to locate an appropriate map would then be evaluated and a decision made as to whether or not to abandon the evaluation or obtain mapping support.

44 Available maps.

The researcher determines which maps are available and extracts the available maps in order to utilize all information possible. This is accomplished by checking indexes and lists of reconnaissance quads, quadrangle maps, river survey maps and "maps by other agencies."

45 Acquire Maps

When the researcher determines that there are available maps that are not included in the Site Inventory System, these maps will be acquired.

46 Visual Comparison.

Visually compare available maps by lying them side by side in order to evaluate and detail errors or characteristics which are different.

47 Natural Constrictions.

Examine available maps for areas of natural constrictions in river basins by looking for areas where contours appear to be in close proximity along streams. Using engineering judgment to determine if these restrictions may be possible dam sites.

48 Reservoirs.

Examine available maps for areas of possible water storage sites (reservoirs) by looking at these maps for broad flood plain areas upstream from natural constrictions. Use engineering judgement to determine if these areas may be possible storage sites.

It is necessary that trained qualified staffs be continually alert to possible sites which have not

been previously identified. Many sites have been identified for specific applications only and not considered for multipurpose sites. Many of these were identified during a time period in which the technologies and needs for a reservoirs were much different than presently. It is important that available maps be examined for possible sites. The evaluation of a site should be done on the most promising site available whether previously identified or located from available mapping.

49 Identify the site to be evaluated.

A point must be picked where to evaluate a potential dam. A descriptive location must be identified as the site that is being evaluated by a Journeyman Engineer. In a natural physical setting there are many options of configuring a dam and reservoir. This initial choice is based on a representative site, although a journeyman engineer choice will be of more benefit than an inexperienced guess.

50 Mapping Decision Point

On March 13, 1986, the existing waterpower experts discussed the initial draft of the WRR Task Statements. From my notes of that date, there were requests to make clear points of decision whether to evaluate the site further, or if they could make the decision with the information already available. Decision Points were subsequently added and were originally called toggle switches (TS). The idea reflected the concept that it was a yes or no decision, that a toggle switch was either off or on. A consciences decision is to be made after examining the available maps for constrictions and storage areas. A journeyman engineer must state that the characteristics of the site warrant further effort.

51 Memorandum to the File.

Once the available mapping has been located and examined, the next step is to write a Memorandum to the File. This communicates findings to other personnel by listing all maps available. List the maps showing the dam site area in the memorandum as well as on the Inventory Site Card. A copy of the Memorandum to the File is part of the Site Evaluation File located under Evaluation File (Site Specific), Geology and Mapping.

If available mapping is not sufficient and a decision is made that mapping support is necessary, wait before ordering the needed support until after further tests are made determining if other site information may change the decision to evaluate the site.

Site Information Search

53 Site Inventory System.

To avoid duplication of efforts, the next step of a site evaluation is to conduct a Site Information Search. This determines what is known about a specific potential site. The Site Card, as defined by the Site Inventory System under Inventory Card File or a database containing similar information, is used as a guide for a site information search. The search finds the information noted on the Site Card in the Classification, Federal Power Projects (FPP), Stream Files as well as available literature and recording notes on the results.

54 Contact other agencies.

Not all available information about a site is located in the waterpower files. For the sake of efficiency, waterpower and reservoir resource specialists should contact other agencies or private companies to obtain more detailed or current information including current planning status. It is appropriate for these individuals to call or visit appropriate corporate or agency offices and then request pertinent information after properly identifying themselves, their purpose and their needs. Once the above tasks are completed, it is essential to document significant findings as to what is known about a potential site in order to communicate these findings to other personnel. This is accomplished by writing a brief, concise, memorandum to the file which summarizes significant findings from site information searches and contacts with other agencies. A copy of the Memorandum to the File is part of the Site Evaluation File located under Evaluation File (Site Specific), Preliminary Investigation.

55 State of the Art Review

A competent evaluation of any waterpower or reservoir resource requires knowledgeable, trained, professional personnel which represents the Bureau of Land Management (BLM) to the Secretary of the Interior. The program is unique and the BLM is responsible to develop individuals to establish and maintain a position of eminence in its special field of identification, evaluation and reporting of waterpower and reservoir resources. Part of the requirements for this specialized staff are the necessary continuing education requirements to stay current with technology and planning for the development of these resources.

The Task is to continually conduct a state of the art review by reading periodicals, newsletters, articles, and by contacting developmental agencies, and attending conferences, and by also taking related courses in order to determine the current technology which is being used in site development and predictions for needed potential site development.

56 Initial Information Decision

On March 13, 1986, the existing waterpower experts discussed the initial draft of the WRR Task Statements. From my notes of that date, there were requests to make clear points of decision whether to evaluate the site further, or if they could make the decision with the information already available. Decision Points were subsequently added and were originally called toggle

switches (TS). The idea reflected the concept that it was a yes or no decision, that a toggle switch was either off or on. A consciences decision is to be made after collecting existing, readily available information and comparing what is known through a state-of-the-art filter. This knowledge may be enough to know that the site is not worth further assessment. A journeyman engineer must state that the characteristics of the site warrant further effort.

Annual Runoff Estimate

A minimum requirement of storage and power producing capability allows a screening of potential sites based on amount of flow. The quick estimate of annual runoff is appropriate at this time. The task is to calculate the possible annual runoff at a potential site in order to determine "ballpark" storage capacities using established techniques.

58 Delineate the Drainage Basin.

Delineate drainage basins for potential sites in order to measure the area of runoff at a potential site by physically marking the drainage boundary on a topographic map. If the site is to be planimetered, the drainage boundary was marked on the reconnaissance scale maps. If there is any potential for the site and drainage area to be digitized, a 7-1/2 degree Geological Survey Quadrangle map is necessary.

59 Calculate the Drainage Area

Planimeter or digitize the marked drainage area in order to determine area for runoff calculations. The area between the site and a gaging station with a known drainage area may be used. Calculate the drainage area and note the calculations on the proper form. The form used by this office for planimetering is shown as part of the Site evaluation File located under Evaluation File (Site Specific), Preliminary Investigation.

60 Calculate The Annual Runoff.

The calculation of the annual runoff can be accomplished in a number of methods. Generally a U. S. Geological Survey gage is located within the drainage basin and the procedure is as follows:

61 Locate the Stream Gage.

Locate the stream gages in the vicinity in order to calculate runoff of dam drainage area by identifying stream gages closest to site.

62 Compare the Drainage Area Ratios.

Calculate a runoff estimate by comparing gage drainage area to site drainage area and

multiplying the ratio times the average annual flow at the gage.

If gaging stations are not available, rainfall station records may be used:

63 Locate an Appropriate Rainfall Station.

Locate rainfall stations in order to calculate runoff of the dam drainage area of the possible site. Compare proximity and similarity of topography and rainfall patterns of rain gaging stations to the possible site using appropriate drawings and maps.

64 Calculate the Annual Runoff.

Calculate annual runoff in order to determine annual quantity of water. Multiply rain fall quantities by appropriate factors to convert to runoff at the potential site.

If runoff quantities are not sufficient to meet minimum requirements, the evaluation of the potential site should not continue. The criteria for minimum size requirements is not based on runoff. Therefore, the waterpower and reservoir resource specialist should be consulted to make a judgement as to whether the time of filling of a reservoir based on the annual runoff is feasible. The other possibility is that the power potential may be increased by the natural location of the reservoir and the site has power potential based on hydrologic head and should be evaluated.

65 Available Water Decision **

CREATING ORIGINAL INFORMATION

The balance of this handbook is based on the assumption that the tasks requested have not been previously completed. It is important not to duplicate any tasks which have already been accomplished. There are also reasons for the chronological order in which the subsequent tasks are presented. The primary sequence is to weed out inappropriate sites early and before too much evaluation time is invested. If the information search discloses any documented flaws in the potential site, further evaluation efforts should not be undertaken without first consulting the waterpower and reservoir resource specialist. It is important that the results of logical groups of tasks be questioned before expending further time in the evaluation. Because the sequence is designed to find flaws in the potential site, the waterpower and reservoir resource specialist should be consulted after each group of task statements.

EVALUATION OF PHYSICAL CHARACTERISTICS

The waterpower and reservoir resource specialist has responsibility for the evaluation, including quality. Very specific requirements for the evaluation which can lead to reports to the Secretary of the Interior include observation of the site, a reconnaissance geologic investigation, and appropriate mapping. The following steps are the responsibility of the waterpower and reservoir resource specialist:

67 Observe the Potential Site

Observe the potential site by locating the site in the field and then coordinating map location with ground location and examining the site for obvious physical constraints in order to confirm the site does exist and that it is not a mapping mistake. Write a memorandum to the file to document and communicate the results. A copy of the Memorandum to the File is part of the Site Evaluation File located under Evaluation File (Site Specific), Geology and Mapping.

68 Decision Based on Appearance

On March 13, 1986, the existing waterpower experts discussed the initial draft of the WRR Task Statements. From my notes of that date, there were requests to make clear points of decision whether to evaluate the site further, or if they could make the decision with the information already available. Decision Points were subsequently added and were originally called toggle switches (TS). The idea reflected the concept that it was a yes or no decision, that a toggle switch was either off or on. A consciences decision is to be made after visiting the site. A journeyman engineer must state that the characteristics of the site warrant further effort.

69 Request a geologic investigation

Request that a geologic investigation be made by submitting formal requests for work to be done, supplying necessary information, and, if necessary, showing the geologist the site in order to determine if there are geological constraints effecting the site. A historical package of memoranda concerning the information in these geological reports is included in Appendix (Historical Information). Write a memorandum to the file to document and communicate the results. A copy of the Memorandum to the File is part of the Site Evaluation File located under Evaluation File (Site Specific), Geology and Mapping.

70 Geology Decision

On March 13, 1986, the existing waterpower experts discussed the initial draft of the WRR Task Statements. From my notes of that date, there were requests to make clear points of decision whether to evaluate the site further, or if they could make the decision with the information already available. Decision Points were subsequently added and were originally called toggle

switches (TS). The idea reflected the concept that it was a yes or no decision, that a toggle switch was either off or on. A consciences decision is to be made after a reconnaissance examination of the geology of the site. A journeyman engineer must state that the characteristics of the site warrant further effort.

RESOURCE INVENTORY: PHYSICAL CHARACTERISTICS

The physical characteristics of a potential site determines how much the site would effect the runoff of the stream. The reason for constructing a reservoir is to control the runoff. The value of the site is dependent upon the amount of control or regulation which the site can provide. The following tasks provide the physical figures which are needed to assess what the site is capable of doing. To be objective, these steps ask for an assessment of the physical dimensions based on topography. If the task is objectively completed, none of the steps will need to be redone for different scenarios or development plans. Often these tasks have been completed for one possible scenario and have then had to be redone if the size would increase.

72 Request Mapping Support

Request mapping support by requesting "ground control" by the appropriate State Office's Cadastral Survey Unit, an aerial reconnaissance flight and then requesting a map be prepared by the Denver Service Center in order to obtain additional information necessary for a site evaluation.

73 Technical Decision Based on Mapping

On March 13, 1986, the existing waterpower experts discussed the initial draft of the WRR Task Statements. From my notes of that date, there were requests to make clear points of decision whether to evaluate the site further, or if they could make the decision with the information already available. Decision Points were subsequently added and were originally called toggle switches (TS). The idea reflected the concept that it was a yes or no decision, that a toggle switch was either off or on. A consciences decision is to be made after examining the available maps. A journeyman engineer must state that the available mapping has sufficient detail to support further evaluation.

Site Location

The following steps are accomplished to establish a site location. State what is to be evaluated by finding the smallest constrictions at the highest reasonable size. An alternative is to chose to evaluate a site at a location documented in the literature search.

75 River Gradient.

Generate information on river gradients by measuring horizontal distances between contour intervals on the most accurate map available in order to determine changes in the river gradient.

Information which needs to be recorded includes contours, bridges, existing dam axis, quadrangle map edges, etc., for future reference. This may be done manually or, if a Geographic Information System (GIS) is available, this information can be computer captured as the stream is being digitized.

76 Stream profile chart.

Construct a preliminary stream profile chart in order to display gradient information using established techniques. This office used a personal computer and charting software to accomplish this Task. The profile was charted with the dam cross-section. If a GIS is used, a check-print is certainly acceptable.

77 Refined Preliminary location.

Mark a preliminary location on the quadrangle map in order to define a point of reference for future consideration. Draw a light pencil mark across the stream channel at a likely constriction after considering the river gradient. Consult with the engineer as to the proposed location.

Dam Height.

Next, consideration must be given to the height which is to be evaluated. In order to state what is to be evaluated, the following steps will set the height of the potential dam by finding the highest reasonable size based on effects, cross-section and storage.

79 Extent of Reservoir.

Determine the extent of the possible reservoir at various levels in order to size the reservoir for reasonableness. Follow contours of reservoir heights looking for "saddles" where dikes are needed, towns, legal constraints, or other items which might limit the size of the reservoir.

80 Cross-section of Dam.

Generate the information for a cross-section of a dam by measuring contours from the center line of the stream along the proposed axis of the dam and listing the values in table form in order to determine its shape for volume and cost estimate. Construct a preliminary cross-section chart using the values table and established procedures in order to display the configuration of a dam. This office used a personal computer and charting software to accomplish this Task. The dam cross-section was charted with the stream profile. If a GIS is used, a check-print is acceptable.

81 Estimate reservoir storage capacity.

Estimate storage capacity of a reservoir by estimating whether the reservoir shape is a prism,

wedge, etc. and making a volume estimate in order to help size a potential reservoir . This will help if there is any question concerning whether the size of the reservoir would be effective.

82 Set height of dam.

Set height of dam by looking at the extent of the reservoir, cross-section of the dam, and estimated storage capacity in order to show what could be evaluated. Then, make an engineering judgement as to the size to be evaluated.

Record Location and Height

Skill and experience will help in locating and sizing a potential reservoir. Generally, the location will be adjusted after the height is set by finding the smallest constriction at that height. Once it has been determined what the location and size of the dam will be, the task is then to document the location and height. Make a chart of the river profile and dam cross-section, mark the site on the quadrangle map and write a memorandum to the file in order to communicate to others what to evaluate.

84 Make Final River Profile Chart.

Construct the final river profile chart by modification of the preliminary river profile chart in order to display river gradient information in a report. Set dam axis at zero mileage by adjusting the mileages on the preliminary river profile in order to display gradient information upstream and downstream of dam axis location.

85 Make Final Cross-section Chart.

Construct a cross-section chart by modification of the preliminary or construction of a new cross-section in order to display cross-section information in a report. Chart to the next higher contour above the high water line in order to display any changes in the cross-section.

Chart the river profile chart with the dam cross-section chart in order to display the information concurrently. Mark the established height of dam in order to display what is to be evaluated by labeling the contour as "High Water Line" An example is located in the Evaluation File (Site Specific), Preliminary Investigation.

86 Write a Memorandum to the File. Write a memorandum to the file to document reasons for location and height by stating reasons why the site has been set at this location and dam height.

Preliminary Illustration File

The following are steps to draw the preliminary location on quadrangle maps to show the location to be evaluated. Draw a dam axis across the constriction and reference leader to edge of the quad.

88 Draw the Dam Axis.

Draw a dam axis to be evaluated by drawing a black line across the smallest constriction to the contour elevation chosen for the set height in order to show location and height. Very lightly extend the dam axis line to the next contour for use for digitizing.

89 Draw the Dam Contours.

Draw dam contours by marking upstream contours in blue and downstream contours in brown in order to show shape and toes of the dam . This office, for the sake of consistency, uses a upstream and downstream slope of 1:2 for all dams.

90 Highlight the High Water Line.

Draw the configuration of the reservoir on all available maps by using established symbols and guides.

Assign a Reference Number

Each potential site is unique and the reference system needs information which will uniquely identify the site. The following steps demonstrate how to identify a unique site by assigning a unique name, number, and review unit, based on location in order to categorize information on the site.

92 Assign a Unique Name.

In order to identify the site, assign a unique name by giving it the name of the nearest upstream tributary or closest land mark.

93 Identify the Hydrologic Unit.

Assign the hydrologic unit in order to identify the site by locating the site on the hydrologic unit map and by specifying the hydrologic unit number.

94 Assign a Site Number.

Assign a site number by appending the next consecutive number in downstream order to the hydrologic unit number in order to identify the site.

95 Draw a Reference Leader.

Draw a new reference leader by drawing a light horizontal pencil line to the edge of the quad in order to identify the marked site. Mark an arrow at the edge. If the drawing has many sites, the leader line is drawn to the nearest edge and constructed perpendicular to the edge. Place the site name, number, and high water line elevation on the quadrangle border in order to communicate to other personnel what has already been investigated.

96 Identify the River Basin File Name.

Assign a river basin file name by looking on established list and determining file name from the hydrologic unit number in order to properly file information on the site. This office grouped and preselected hydrologic units into file names. A list of these file names is included in Appendix (Historical Information), Basin Names.

97 Write a Paragraph Identifying the Site and Its Location.

The paragraph should use the chosen site name and number and describe the site's proper location by state, county, meridian, rectangular land grid, river mile, altitude, and coordinates. This paragraph will be used in the final report and is useful information in the working file.

Prepare a Site Identification Card

Communication of the size and location of a site includes documenting the information on a Inventory Site Card, showing the configuration on reference maps, and properly filing the information for quick retrieval.

99 Fill Out a Site Inventory Card.

Fill out or update a site inventory card or the "CARDS" database by entering the information on a prescribed card and database in order to communicate to other personnel. It may be necessary to initiate a complete new card.

100 File the Information.

File all of the above described information for a site in the stream files, map files, card files, technical files and library in order to maintain for future reference. Prepare the site information package in a notebook as a handy data collector. Prepare a quadrangle map package to submit for digitization. (This office uses a three ring binder as the site evaluation file while the site is under active evaluation.)

AUTOMATION OF INFORMATION

The automation of site information by digitizing is cost effective and should be considered. It is recommended that information be communicated to staff responsible for digitization at this time in the evaluation process. This will avoid delays when results of the computers calculations are needed. The following steps are completed in order to accomplish the digitization of those sites to be evaluated, in order to obtain area capacity curves, volume, and mapping capabilities.

Digitization

103 Digitize Hydrologic Unit Boundaries.

Digitize the hydrologic unit boundaries by utilizing a digitization table and following the hydrologic unit lines marked in order to computer capture information on basin drainage configuration. For illustration applications, this office digitized the boundaries from the Hydraulic Unit Map.

104 Digitize Streams and Gages.

Digitize streams and gages by utilizing a digitization table and following streams shown and by marking points where gages exist or have existed in order to computer capture information on streams and gages. The capturing of the stream intersections with contours, quadrangle edges, bridges, etc., is very helpful information. It is used for stream profiles.

105 Mark themes.

Mark themes and instructions on quad maps by writing names, codes, and themes on quadrangle maps of items to be digitized in order to instruct digitizers of workload. This office enters themes and instructions into a personal computer database software application called "GIS" to confirm all necessary quads have been marked and that data has been identified for future mapping needs. The report portion of the database is useful for obtaining a printout of instructions for the sites in the basin.

106 Meet with Cartographic Personnel.

Meet with Cartographic personnel in order to communicate, plan, and monitor progress by discussing work assignments, work accomplishments, unique job challenges, etc. The Colorado State Office (CSO) utilizes a group of personnel on the GIS Staff to digitize themes for the statewide programs centralized in the CSO. This group provided digitization support for the Waterpower Staff.

107 Digitize Dam and Reservoir.

Digitize dam and reservoir configuration by utilizing a digitization table and capturing points, lines, and polygons in order to computer capture information on location, size, and shapes. Details on the method previously developed for the digitization of waterpower dams and reservoirs are included in this handbook under Appendix (Procedures), GIS - MOSS Themes.

108 Digitize Public Land Survey Lines.

Digitize public land survey lines by utilizing a digitization table and following the land survey lines shown in order to computer capture information on location parameters. This step will be unnecessary when the Geographic Coordinate Data Base presently under development is finished.

109 Digitize Withdrawals.

Digitize withdrawals by utilizing a digitization table and following the withdrawal lines marked in order to computer capture information on location, size, and shape.

Calculations and Maps

The information is captured in either the Automated Mapping System or Automated Digitizing System. Then, the information needs to be converted to the Map Overlay and Statistics System, Cartographic Output System, or Map Analysis Processing System in order to produce check prints or mapping products. The calculations of areas and volumes can be done with digitized information or from planimetered figures. The advantage of digitization is the availability of the information for other applications.

111 Calculate Volumes of Dams and Reservoir.

Calculate volumes of dams and reservoirs by averaging successive areas and multiplying the distances between areas and cumulatively summarizing results in order to determine effects of the dam on the streamflow. This office used a Personal Computer (PC) and spreadsheet software to accomplish this task. The name for the application was "AREADIG.SSF." The traditional way to obtain information for an area capacity curve is to planimeter areas of contours and to calculate the volume of reservoir by multiplying average areas by vertical distances between the areas. This office used a personal computer and spreadsheet software to compute the volume. The name of the application was "AREAPLN.SSF."

112 Construct a Table of Areas and Capacities.

Construct a table of areas and capacities at various reservoir elevations by listing the areas and capacities at each elevation at which they were measured or calculated in order to determine the characteristics of the reservoir. Chart the figures from the area-capacity table in order to display

the results for better understanding. This office used a personal computer and chart software for this exercise. An example is found in the Evaluation File (Site Specific), Area Capacity.

113 Document Unusual Circumstances.

The opportunity to create a complete area-capacity curve does not always exist. Examples include obtaining an area-capacity curve from another agency or creating the area-capacity curve of the volume above a natural lake. Document these unique circumstances by writing a memo to the Evaluation File describing why the task was different, how the task was accomplished, and the results in order to communicate the information to other personnel.

Automated Mapping

115 Generate Check Prints.

Generate check prints as an overlay of quadrangle maps using established procedures in order to provide a visual display of potential reservoirs and withdrawals.

116 Generate a Location Diagram.

Generate a location diagram for use on the cover of the final report. An example is included under Report (Final).

117 Generate a Vicinity Map.

Generate a vicinity map for use in the final report. An example is included under Report (Final).

118 Generate a Site Map.

Generate a site map for use in the final report. An example is included under Report (Final).

HYDROLOGY

Every portion of every stream is unique when compared to any other portion. The prudent examination of hydrological conditions requires a broad perspective of basin conditions to avoid the entrapment of the circumstances of the local stream. Modeling of flows and reconstruction of flows are often necessary due to lack of information. The steps presented here are targeted at obtaining the best information for a reconnaissance evaluation of a potential site.

Water Balance

One way of ensuring that adequate information is available to the professional is to conduct a water balance of the entire basin. A statement outlining the procedures is included in Appendix (Historical Information).

The following steps are to conduct a water balance of the basin by comparing average stream flows of gages, calculates average flow of stream records, checks for additional gages, and locates ungaged areas in order to account for flow in tributaries and main streams.

121 Select Long Term Gages.

Select long term gages in a basin on a river and tributaries by utilizing the index of water surface records. Select records with over a 20 year period on the main stream and near the mouth of the tributaries in order to have both wet and dry periods of record. Also, note significant diversions from the basin.

122 Retrieve Significant Gage Records.

Retrieve or construct significant gage records in order to evaluate hydrology of a stream. This office used a Personal Computer (PC) and a communications software to access the Geological Survey's computer data on streamflow records called "WATSTOR." The data was captured into a spreadsheet available for applications. Occasionally, diverted flows or complementary gage data need to be added. Details of this procedure is located under APPENDIX (Procedures), Watstor/Wylbur.

123 Select the Period of Record.

Select the longest practical period of record by plotting length of significant gages and choosing common periods of time, in order to encompass both wet and dry periods. This can also be done with spreadsheets and charting software on a Personal Computer.

124 Summarize the Average Stream Flows.

Summarize average stream flows of gages by obtaining gaged or calculated flow values (of

drainage areas contributing to a gage), and adding the values. Compare their total to the actual gaged flows in order to account for all flows of tributaries and mainstream flows.

If there are insufficient flows to balance between summary flows and gaged flows:

125 Calculate the Common Average Flow.

Calculate the common average flow of stream records by recomputing an average flow for the common period of time, in order to make the flows span the same period of record. In some cases, a gage's record may have to be extended. This office used a Personal Computer (PC) and a spreadsheet software package with an application called "GAGEEXP.SSF" to accomplish this task. Summarize average stream flows of gages using these new figures.

126 Check for Additional Gages.

Check for additional gages to substantiate more flow by selecting gages of tributaries which have significant flows but were not initially used. Summarize average stream flows of gages using these new figures.

127 Calculate Flows From Ungaged Areas.

Calculate flows from ungaged areas by dividing the overall drainage by the gaged drainage; multiply the gaged flows by this ratio; then, subtract the gaged flows in order to substantiate more flow. Add these calculated flows to the original calculations and summarize average stream flows of gages using these new figures.

128 Construct a Map of Gages.

Construct a map of gages used by making a map of the streams and showing the gages used, using established procedures in order to display their relationship to each other.

129 Construct a Runoff Evaluation Chart.

Construct a "runoff evaluation chart" by plotting together gage records, gage relationships, and flow amounts using established procedures in order to allow reviewers a method of seeing results of the water balance.

Convey the Results of the Water Balance

The water balance results will be used many times and the results should be documented in a manner which will quickly convey the information. The following steps are one way to convey the results of the water balance.

131 Finalize a Map of Gages.

Construct a map of gages used by making a map of the streams and showing the gages used, using established procedures in order to display their relationship to each other.

132 Finalize a Runoff Evaluation Chart.

Construct a "runoff evaluation chart" by plotting gage records, gage relationships, and flow amounts together using established procedures in order to allow reviewers a method of seeing results of the water balance.

133 Determine Basin Wide Drought and Wet Periods.

Determine basin wide drought and wet periods by visually scanning natural hydrographs or spreadsheets and choosing appropriate times of wet or dry runoff in order determine periods in which all storage requirements should be evaluated. These periods may be colored for better visualization.

The basin water balance and documentation are filed in the "General" section of the Stream Files when the balance encompasses more than one stream.

Site Hydrology

The reason to construct a potential site is to provide the operator of the dam the ability to alter the natural flow patterns. The site will be designed to provide the projected needed control as economically as possible. Essential to the planning for the project is an understanding of the characteristics of the stream which is to be altered. The following steps allow a model to be built if actual gage records are not available and the available methods of documenting the characteristics of the flow.

Select a stream gage to use in evaluating a site by looking for gages on the stream in the proximity and in the same or similar weather pattern. The example in the Site Evaluation File needed only the addition of three gages to provide total flow for a sufficient period of time.

Often a single gage will not be sufficient due to a shortage of the length of record or interrupted flow records. Complementary records are chosen and the record of the initial gage is modeled for the missing years. The following steps are the procedures for modeling runoff records. The first step is to select a gage to utilize for missing flows. This is done in order to project flows into ungaged time records by looking for gages in the same precipitation pattern with complementary but overlapping periods of record. Compare readings for common years, compare ratios of common averages to overall averages, and select the gage to be used.

135 Note and List All Long Term Gages.

Note and list all long term gages in the same precipitation pattern by listing gages with more than 15 years of record as well as their locations and years of record.

136 Retrieve Significant Gage Records.

Retrieve or construct (if necessary) significant gage records in order to compare data to the selected gage data. This office used a personal computer and captured data from the U.S. Geological Survey's data base of gage records called "WATSTOR" and then entered the data into a spreadsheet. Occasionally diverted flows or complementary gage data needs to be added.

137 Determine Location and Time Relationships.

Determine location and time relationships between long term gages by visually comparing the years of record, and selecting those with needed periods and overlapping records in order to ignore gages with unneeded periods of record.

138 Correlate Between Selected Gage Data.

Correlate between selected gage data and the gage to be used to project time in order to visually compare characteristics of the gages for similarities. This office used a personal computer, a spreadsheet software package, and a chart software package. The applications were labeled "GAGEEXP.SSF" spreadsheet and "COMPARE.CHT" chart.

139 Determine Gage to be Used.

Determine gage to be used in order to extend the selected gage's period of record by making a hydrology judgement as to which gage compares the most favorably.

The selection of the gages in the same precipitation pattern, with comparable characteristics in common years of operation, then allows the substitution of missing flows by ratio methods.

140 Project Gaging Time Period of Record.

Project gaging time period of records by multiplying selected monthly readings by a ratio of common record averages in order to project the flows into wet or dry years. This office used a personal computer and a spreadsheet software. The application was titled "GAGEEXP.SSF."

141 Sreamflow Inventory Decision

On March 13, 1986, the existing waterpower experts discussed the initial draft of the WRR Task

Statements. From my notes of that date, there were requests to make clear points of decision whether to evaluate the site further, or if they could make the decision with the information already available. Decision Points were subsequently added and were originally called toggle switches (TS). The idea reflected the concept that it was a yes or no decision, that a toggle switch was either off or on. A consciences decision is to be made after examining the available streamflow records and the attempts to construct a long term gage record. A journeyman engineer must state that the available information is sufficient to warrant further effort.

142 Write a Memorandum to the File.

Write a memorandum to the file to document and communicate the results. A copy of the Memorandum to the File is part of the Site Evaluation File located under Evaluation File (Site Specific), Stream - Flows Used.

The procedures for modeling flows when the gages are not in the same drainage, precipitation pattern, nor have similar runoff characteristics, requires hydrology expertise and is beyond the scope of this handbook. Note that experience has indicated that the above procedure does work well in most instances.

Determine and Analyze the Seasonal Distribution of Flows

The next step is to determine and analyze the seasonal distribution of flows at a site. This will be used to determine any effects of a possible dam on the runoff by transferring gage data to the site, chart characteristics of the data, and calculating storage requirements needed for releases.

144 Transfer Monthly Flows from Nearby Existing Gages.

Transfer monthly flows from nearby existing gages by calculating monthly flows at the dam site by drainage area ratios in order to determine seasonal patterns of runoff. This office used a personal computer and a spreadsheet software package to accomplish this task. The application was named "FLORATIO.SSF."

145 Plot a Natural Hydrograph.

Plot a natural hydrograph by plotting monthly flows as they occur on a graph in order to depict seasonal distribution of runoff flows . This office used a personal computer and a chart software package to accomplish this task. The application was named "HYDRO?.CHT." This chart was plotted with the chart of regulated flows and the drawdown in the potential reservoir. A copy is part of the Site Evaluation File located under Evaluation File (Site Specific), Hydrology Results.

146 Calculate and Plot a Mass Curve Diagram.

Calculate and plot a mass curve diagram by adding monthly flows and plotting accumulated results on a graph in order to depict accumulated runoff and seasonal distribution. This office used a personal computer and a chart software package to accomplish this task.

147 Calculate and Plot a Duration Curve.

Calculate and plot a duration curve by sorting and "ranking" monthly flows, determining the percent which various flows occur, and plot the results on a graph in order to show long-term percentage of runoff distribution. This office used a personal computer and a chart software package to accomplish this task.

148 Calculate and Plot Average Monthly Flows.

Calculate and plot average monthly flows by averaging each months flows over the time period and then charting the results in order to depict a typical year of average months. This office used a personal computer and a chart software package to accomplish this task. The application was named "MONTHLY.CHT." This is plotted with a chart of the average regulated monthly flows. A copy of the combined chart is part of the Site Evaluation File located under Evaluation File (Site Specific), Hydrology Results.

149 Find the Storage Required to Release Percentages of the Flow.

Find the storage required to release certain percentages of the average annual flow by setting the required releases to percent of average flow desired, and then "routing" flows to obtain storage required. This office used a personal computer and a spreadsheet software package to accomplish this task.

150 Plot a Curve of Percentages.

Plot a curve of percentages (regulation curve) by plotting percentages versus storage required in order to demonstrate macroscopic characteristics of seasonal distribution. This office used a personal computer and a chart software package to accomplish this task. The application was named "REGCURVE.CHT." Write a memorandum to the file to document and communicate the results. A copy of the Memorandum to the File and the chart is part of the Site Evaluation File located under Evaluation File (Site Specific), Regulation Curve.

151 Document Results of the Hydrology Evaluation.

Document results of the hydrology evaluation by writing a memo to the file and summarizing results in order to communicate to other personnel. This office used a personal computer and a spreadsheet software package to accomplish this task. The application was named "PURSUM.SSF." A copy of the Memorandum to the File is part of the Site Evaluation File located under Evaluation File (Site Specific), Hydrology Results.

SITE EVALUATION

The following steps demonstrate how to analyze and document the effects that a potential site has on the natural distribution of flows on a stream.

Hydrology

The first step is to compute the possible routing of flows through the reservoir in order to determine possible storage affects of a site by using an accounting technique. This office used a Personal Computer (PC) and a spreadsheet software package to accomplish this task. Two spreadsheets were used called "CUMSUM.SSF" and "ROUTING.SSF." The results were then plotted using a PC plotting software called "CHART."

154 Determine a Reasonable Active Storage.

Determine the reasonable active storage in order to determine realistic affects of the reservoir. This is accomplished by establishing a reasonable drawdown to be allowed and then determining the storage capacity in that drawdown.

155 Find the Percent of Regulation.

Find the percent of regulation which the reservoir will provide by using the regulation curve as a guide for releases. Find the largest release possible with the active storage and then divide by the average flow (as a percentage) in order to state a measurement of the effectiveness of a reservoir. This is done concurrently with calculating the effects.

156 Calculate Affects of a Potential Reservoir.

Calculate affects of a potential reservoir by addition of inflows and subtraction of outflows from the reservoir contents, using historical stream flows in order to determine possible stream regulation. This is done concurrently with finding percent of regulation.

157 Determine the Regulated Flows.

Determine the regulated flows by adding corresponding releases and spills from the routing in order to demonstrate effects of the potential reservoir.

The following steps show the results of the routing of flows through the reservoir by visually showing the difference before and after routing in order to evaluate the impact. The flows after routing are regulated flows.

158 Plot a Hydrograph After Regulation.

Plot a hydrograph after regulation in order to visually show the difference between the natural and the regulated hydrographs. This office used a Personal Computer (PC) and a plotting software package called "CHART" to accomplish this task. This hydrograph was plotted with the natural hydrograph to visually show the effects of the potential reservoir. A copy of this chart is part of the Site Evaluation File located under Evaluation File (Site Specific), Hydrology Summary.

159 Calculate and Plot a Mass Curve Diagram for Regulated Flows.

Calculate and plot a mass curve diagram for regulated flows in order to visually show the difference between the natural and regulated mass curve. This office used a Personal Computer (PC) and a spreadsheet software package called "CHART" to accomplish this task.

160 Calculate and Plot a Duration Curve of Regulated Flows.

Calculate and plot a duration curve of regulated flows in order to visually show the difference between the natural and regulated duration curve. This office used a Personal Computer (PC) and a spreadsheet software package called "CHART" to accomplish this task.

161 Calculate and Plot Average Monthly Regulated Flows.

Calculate and plot average monthly regulated flows in order to visually show the difference between the natural and regulated monthly flows. This office used a Personal Computer (PC) and a spreadsheet software package called "CHART" to accomplish this task. This chart was plotted with the natural average flows. A copy of the chart is part of the Site Evaluation File located under Evaluation File (Site Specific), Hydrology Results.

162 Decision Based on Routed Flows **

On March 13, 1986, the existing waterpower experts discussed the initial draft of the WRR Task Statements. From my notes of that date, there were requests to make clear points of decision whether to evaluate the site further, or if they could make the decision with the information already available. Decision Points were subsequently added and were originally called toggle switches (TS). The idea reflected the concept that it was a yes or no decision, that a toggle switch was either off or on. A consciences decision is to be made after examining the available maps for constrictions and storage areas. A journeyman engineer must state that the characteristics of the site warrant further effort.

Hydroelectric Power

Part of the effects of a potential reservoir can be measured by the impact which the reservoir has on hydroelectric power potential. The following steps guide the analysis of these effects by

calculating the hydroelectric potential at a site in order to determine possible value of a site by using calculator or computer and established techniques.

164 Estimate the Power Potential of the Reach of the River.

Estimate the power potential of the reach of the river if power were developed by diversion conduit methods. Use the total fall of the river from the high water line of the reservoir to the downstream toe of the potential dam and established methods.

165 Determine the Average Reservoir Fluctuation.

Determine the reservoir fluctuation in order to determine average fall for hydroelectric potential. Using the area-capacity curve and reservoir contents each month, and calculate the surface level each month (which is averaged). This average level minus the powerhouse level is an approximate average fall. This office used a Personal Computer (PC) and a spreadsheet software package called "DRAWDOWN.SSF" to accomplish this task. The Bureau has the Corps of Engineer's Hydrologic Engineering Center's (HEC) Fortran programs on the Honeywell level 8 computer which accomplishes similar calculations. An example is part of the Site Evaluation File located under Evaluation File (Site Specific), Routed Flows.

166 Determine "Firm" Power.

Determine "firm" power by utilizing average head and "firm" release calculate kilowatt hours/year using established techniques in order to find the reservoir's power potential.

167 Determine "Secondary" Power.

Determine "secondary" power by utilizing spill and total head, calculate kilowatt hours/year using established techniques in order to find the reservoir's power potential.

168 Determine "Total" Power.

Determine "total" power by adding the "firm" and "secondary" power values together in order to find the reservoir's power potential.

169 Compare the Power Produced.

Compare the power produced from the potential reservoir to the power production estimate by diversion conduit.

170 Decision Based on Hydroelectricity

On March 13, 1986, the existing waterpower experts discussed the initial draft of the WRR Task Statements. From my notes of that date, there were requests to make clear points of decision whether to evaluate the site further, or if they could make the decision with the information already available. Decision Points were subsequently added and were originally called toggle switches (TS). The idea reflected the concept that it was a yes or no decision, that a toggle switch was either off or on. A consciences decision is to be made after demonstrating the hydroelectricity potential of the site. A journeyman engineer must state that the hydroelectric potential of the site warrant further effort. Specifically, does the potential warrant evaluating upstream affects or downstream effects.

Multiple Sites

Many streams already have reservoir sites developed which have to be considered. The waterpower and reservoir resource specialist must have a way to determine the effects of upstream sites or possible effects on downstream sites in order to determine possible value of a site. This is accomplished by using modeled regulated outflows of potential sites upstream as inflows instead of natural flows. The regulated flows with regulated inflows can then be compared to regulated flows with natural inflows. The increase in regulation and annual power is attributed to the upstream potential site.

Recalculate Site's Hydrology Using Outflows From the Site Upstream **

173 Determine the Regulated Flows **

174 Plot a Hydrograph after Regulation **

175 Calculate and Plot a Mass Curve Diagram for Regulated Flows **

176 Calculate and Plot a Duration Curve of Regulated Flows **

177 Calculate and Plot Average Monthly Regulated Flows **

Recalculate Hydroelectric Power Using Outflows from Upstream Site **

179 Determine "Firm" Power **

180 Determine "Secondary" Power **

181 Determine "Total" Power **

182 Compare the Power Produced **

183 Affects & Effects Decision **

On March 13, 1986, the existing waterpower experts discussed the initial draft of the WRR Task Statements. From my notes of that date, there were requests to make clear points of decision whether to evaluate the site further, or if they could make the decision with the information already available. Decision Points were subsequently added and were originally called toggle switches (TS). The idea reflected the concept that it was a yes or no decision, that a toggle switch was either off or on. A consciences decision is to be made after determining how this site is effected by upstream sites and how this site affects sites located downstream. A journeyman engineer must state that the effects and affects of the site warrant further effort.

VALUE DETERMINATION

A value determination is arrived at by realistically sizing the potential reservoir and then investigating how it meets the needs for a reservoir.

Hydroelectric Economics

One economic factor which can be used to help size a reservoir is hydroelectric power. It is usually sufficient to calculate economics of producing total power by calculating the cost per kilowatt hour. This is achieved by using established procedures in order to determine the reasonableness of the site.

If it is determined to be helpful for the reasonable sizing of the reservoir, the following steps calculate economics of producing total power at each level by calculating the cost per kilowatt-hour in order to make a decision on the value of the site.

186 Calculate the Active Capacities at Each Reservoir Level.

Calculate the active capacities at each reservoir level by subtracting the capacity of the level of lowest drawdown to obtain capacity of a reasonable drawdown This is done in order to determine the effects on the stream.

187 Determine Regulated Flows at Each Reservoir Level.

Determine regulated flows at each reservoir level by routing the flows through the reservoir using established procedures in order to measure the effects on the stream.

188 Determine Reservoir Fluctuations at Each Reservoir Level.

Determine reservoir fluctuations at each reservoir level in order to calculate average head using established procedures.

189 Determine Power Produced at Each Reservoir Level.

Determine power produced at each reservoir level in order to determine economics of the site by using established procedures.

190 Calculate the Economics of Producing Power at Each Reservoir level **.

On March 13, 1986, the existing waterpower experts discussed the initial draft of the WRR Task Statements. From my notes of that date, there were requests to make clear points of decision whether to evaluate the site further, or if they could make the decision with the information

already available. Decision Points were subsequently added and were originally called toggle switches (TS). The idea reflected the concept that it was a yes or no decision, that a toggle switch was either off or on. A consciences decision is to be made after examining the available maps for constrictions and storage areas. A journeyman engineer must state that the characteristics of the site warrant further effort.

191 Make an Economic Curve. Make an economic curve by charting the calculated costs at various reservoir levels using the PC's chart software package and established procedures in order to determine if there are reservoir levels that have economic advantages. A copy of these calculations and chart is part of the Site Evaluation File located under Evaluation File (Site Specific), Value / Economics.

192 Make a Decision Based on Economics **.

On March 13, 1986, the existing waterpower experts discussed the initial draft of the WRR Task Statements. From my notes of that date, there were requests to make clear points of decision whether to evaluate the site further, or if they could make the decision with the information already available. Decision Points were subsequently added and were originally called toggle switches (TS). The idea reflected the concept that it was a yes or no decision, that a toggle switch was either off or on. A consciences decision is to be made after examining the available maps for constrictions and storage areas. A journeyman engineer must state that the characteristics of the site warrant further effort.

Realistic Sizing

194 Choose a Reasonable and Defendable Size.

Choose a reasonable and defendable size for the potential dam. Do so by utilizing stream profile, dam cross-section, area capacity, routing of flows, hydroelectric potential and economics data to make an engineering judgement regarding a reasonable dam size. This is done in order to minimize the size of site and withdrawals. Caution: This applies to a typical site. Non-typical sites for special problems deserve special consideration. Knowledge of the basin problems is to be considered by the waterpower and reservoir resource specialist in sizing the reservoir. Write a memorandum to the file to document and communicate the results. A copy of the Memorandum to the File is part of the Site Evaluation File located under Evaluation File (Site Specific), Value/Economics.

195 Make a Statement of Performance.

Make a statement of performance of the site by writing a narrative statement of the results of the previous evaluations in order to determine the value of the site. Write a memorandum to the file to document and communicate the results. A copy of the Memorandum to the File is part of the

Site Evaluation File located under Evaluation File (Site Specific), Value / Economics.

Value Decision

197 Assign Present or Future Deficiencies.

The waterpower and reservoir resource specialist will assign present or future deficiencies to an area by utilizing "state-of-the-art" data to form conclusions on future needs. This is done in order to evaluate future need for a site. A memorandum to the staff outlining the importance of this task is included in Appendix (Historical Information), Deficiencies / Decision. A copy of the Memorandum to the File is part of the Site Evaluation File located under Evaluation File (Site Specific), Value / Economics.

198 Make a Decision Based on Deficiencies **.

On March 13, 1986, the existing waterpower experts discussed the initial draft of the WRR Task Statements. From my notes of that date, there were requests to make clear points of decision whether to evaluate the site further, or if they could make the decision with the information already available. Decision Points were subsequently added and were originally called toggle switches (TS). The idea reflected the concept that it was a yes or no decision, that a toggle switch was either off or on. A consciences decision is to be made after examining the available maps for constrictions and storage areas. A journeyman engineer must state that the characteristics of the site warrant further effort.

199 Make a Statement of Benefits.

The waterpower and reservoir resource specialist will make a statement of benefits to be provided by the potential site. This is accomplished by noting which of the deficiencies or needs can be completely met or partially met by the potential reservoir in order to summarize the value of the site. A memorandum to the staff outlining the importance of this task is included in Appendix (Historical Information), Deficiencies / Decision.

200 Make a Decision Based on Contributions **.

On March 13, 1986, the existing waterpower experts discussed the initial draft of the WRR Task Statements. From my notes of that date, there were requests to make clear points of decision whether to evaluate the site further, or if they could make the decision with the information already available. Decision Points were subsequently added and were originally called toggle switches (TS). The idea reflected the concept that it was a yes or no decision, that a toggle switch was either off or on. A consciences decision is to be made after examining the available maps for constrictions and storage areas. A journeyman engineer must state that the characteristics of the site warrant further effort.

201 Make a Professional Decision.

The waterpower and reservoir resource specialist will make a professional decision if the potential site warrants consideration for future development. This is determined by applying good engineering judgment to the results of this evaluation. This decision should be recorded and signed. The copy of the form used in the regional office is included in Appendix (Historical Information), Deficiencies / Decision. Write a memorandum to the file to document and communicate the results. A copy of the Memorandum to the File is part of the Site Evaluation File located under Evaluation File (Site Specific), Decision.

Documentation

The defense of the decision concerning the value of a site relies on documentation, illustration, and quick retrieval. It is important to document the results of all investigations. Make complete and clear notes, calculations, and drawings and ensure their placement in the proper files in order that subsequent engineers will not have to re-evaluate the site.

203 Modify the Existing Drawing of Dams and Reservoirs.

If necessary, modify the existing drawing of dams and reservoirs on all available maps by using established symbols and guides in order to communicate to other personnel what has been selected as reasonable.

204 Review the Professional Decision, if the Drawings Were Modified **.

Review the professional decision if the drawings were modified.

205 Update the Site Inventory Card.

Update the site inventory card by filling in the blanks on a prescribed card in established format in order to communicate site information to other personnel. The card is to be completely filled out as much as possible. It may be necessary to initiate a new card.

206 Show Final Calculation and Results.

Show planimeter and calculation results for checking or use by neatly listing the methods and figures used on established forms. This clearly communicates results to other personnel.

207 Show Curves, Hydrograph and Diagrams.

Show the area-capacity and duration curves, hydrograph and mass diagrams by drawing curves, using established procedures on approved format in order that results may be utilized by other

personnel.

208 Write a Concise Narrative of the Results.

Write a concise narrative of the results using established format. This summarizes results of the investigation and more effectively communicates what has been accomplished. A copy of the Memorandum to the File is part of the Site Evaluation File located under Evaluation File (Site Specific), Decision.

209 Finalize and File the Site Evaluation Report **.

Finalize and File all above described information for a site in the stream files, map files, card files, FPP files, technical files, and library in order to maintain them for future reference.

ADJUST THE LAND VALUE FILES

The land which may be inundated by a potential reservoir have unique value which, by statute, are to be withdrawn. Identification of those land requires a unique combination of skills. The concept of a fluctuating reservoir with flood control capacity occupying land is usually new concept to realty personnel. Often the concept of land use authorizations and adjudication are foreign to those familiar to reservoirs. The assessment of lands involved, their potential value, and their withdrawal status are addressed. The discipline and responsibilities change from the engineering technician to that of a realty specialist.

Withdrawn Valuable Land

The first step is to determine what lands values have been identified previously. This can be quickly communicated visually by showing already identified potential sites with the existing withdrawals. The following listed steps are accomplished manually but efficiency dictates automation be used. If the reservoir sites are digitized and the Geographic Coordinate Data Base and Legal Land Description files are available, this process can be completed on a terminal screen.

212 Determine the lands Effected by Resources.

Determine the smallest legal subdivisions effected by a reservoir by listing the subdivisions within or effected by the dam or high water line in order to assign a value to the land subdivisions.

213 Determine the Land Acreage for Each Resource.

Determine the total land acreage in each classified reservoir by adding the acreage for each subdivision listed.

214 Determine the Subdivisions of Each Withdrawal Effected

Determine the smallest legal subdivision of each withdrawal effected by a site by noting subdivisions within, or effected by, the dam or high water line to assign a value to the subdivisions.

215 Assign a Resource Value to Effected Withdrawals

Assign a reservoir value to the effected withdrawn lands by placing the reservoir site name in the value column of each subdivision effected to document known values.

Non-Valuable Land

217 Determine Withdrawals Without Resource Values

Determine the smallest legal subdivision of each withdrawal not effected by any reservoir site by noting subdivisions outside or not effected by any reservoir site in order to remove any assigned value from the subdivisions.

218 Assign a Lack of Value to Appropriate Withdrawals

Assign a value or the lack of a value to the withdrawn lands not effected by a reservoir. List other values, or the reason for a lack of value, by listing the value or reason for lack of value in the "value" column of each subdivision. This documents the findings.

Land Administration and Constraints

220 Determine the Land Status of Effected Lands.

Determine land status of effected lands by obtaining Master Title (MT) plats and Historical Indexes and checking the land lists with the status records in order to adjust classifications effecting vacant public lands.

221 List All Effected Federally Owned Lands.

List all Federally owned lands which are protected for their water resource value by withdrawal. List all vacant public lands not protected by any withdrawal. These steps communicate results to other personnel for checking or for their use.

222 List the Land Administration Agency.

List the land administration agency of each subdivision from statewide status maps on the "summary sheets" in order to determine reactive workloads for those agencies . The sites and the acreage in each agency should be tabulated and the information shared with the management agency.

REPORTS

The Reporting requirements are to convey the professional decision and information about potential sites. The information is conveyed to planners, adjudicators, realty specialists, managers, other federal, state, and local agencies, and the general public. Reporting formats consist of memoranda, illustrations, and publications. Procedures are in the order of their complexity.

224 Convey Information on Professional Decisions to Lands Personnel **.

Convey information concerning the professional decisions on potential sites to lands personnel to enable them to make adjustments or justify the withdrawals. This is usually in the form of memorandums to appropriate personnel. The guidance provided to the Colorado State Office as Instructional Memorandum No. CO-86-302 is included in Appendix (Procedures), Withdrawals.

2. Memorandums are usually all that are required to furnish information to interested parties (federal, state, local or private) to enable others to utilize this information by responding to individual inquires.

3. Planners and land managers require illustrations to show the potential reservoir. This is accomplished by furnishing them copies of marked digitized quadrangle overlays and documented data.

The waterpower and reservoir resource specialist should encourage the preparation of a report on the potential site by stating the decision and supporting justification, using both standard statements and specific information in order to convey decisions on the site. The following are necessary steps.

225 Request Location Map, Site Map, and Cadastral Overlays.

Request location map, site map, and cadastral overlays from the Graphics Section in order to complete the report.

226 Construct Maps of the Location, Shape, and Size.

Construct maps of the location, shape, and the relative size of the dam and reservoir by plotting the high water lines as a polygon on location maps, or plotting contours and dam configuration for justification packages, or making an overlay of dams for Resource Management Planning efforts in order to convey information to others.

227 Request Final Area-Capacity Curve **

228 Request Typesetting.

Request typesetting from the Graphics Section in order to prepare the report.

229 Request a Final Area-Capacity Curve and the Report Cover Sheet.

Request a final Area-Capacity curve and the Report Cover Sheet from the Graphics Section in order complete the report.

230 Assemble the Report.

Assemble the report on the potential site by placing the cover, written material, graphics, and maps in final format. Copy the report and send it to others. Note that the written material was written as each step occurred.

231 Prepare a Transmittal Memorandum.

Prepare a transmittal memorandum in order to send the report according to established procedures.

232 Send the Site Report and Cadastral Overlays.

Send the site report and cadastral overlays to the appropriate land managers in state and District offices in order to convey information.

POST SCRIPT

Management required individuals to initial a check list for essentially two reasons: 1) The check list served as a reminder of the sequence and tasks to be accomplished; 2) Responsibility for the task was acknowledged and pride and accountability was ensured.

Complete the provided check-off list by signing initials and date completed in order to assure completeness and responsibility .

In the APPENDIX (Historical Information), Civil Service, is a outline statement of how the task statements were developed and why the project was started that led to this handbook. The development of the task statements provided a avenue to clarify the roles and different disciplines required to accomplish the function. The employees themselves participated in the assignment of tasks and how the task was accomplished. The task statements were revised several times and should continue to be updated to be effective. The result of one time span of documentation of time and discipline per task is. A copy of a spreadsheet application that tracked time and discipline is included under APPENDIX (Task Statements).

FORMAT

I. Level One:

ALL CAPS, BOLD, CENTERED ON ITS OWN LINE, 18 POINT FONT.

A. Level 2:

Capitalize Each Major Word, Bold, Centered on its own Line, 16 Point Font.

1. Third level:

Capitalize Each Major Word, Bold, Left Justified on its Own Line, 14 Point Font.

a. Fourth level:

Capitalize Each Major Word, Bold, Left Justified on its Own Line, 12 Point Font.

(1) Fifth level:

Capitalize Each Major Word, Bold, Left Justified on its Own Line, 12 Point Font, Italic.

Actual paragraph style is flush left (no indent). One line space between paragraphs.

Short (1-2) sentence paragraphs should probably be bulletized rather than done as separate sections.

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BLM Library
Denver Federal Center
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P.O. Box 25047
Denver, CO 80225